

# The Role of the Commercial Sector in the Nation's Space Weather Program "R2O"

**Geoff Crowley**

*President/Chief Scientist, ASTRA LLC*

*Executive Board Member, American Commercial Space Weather Association*



R2O Workshop

August, 2016

**ASTRA**

**Atmospheric & Space Technology  
Research Associates, LLC**

# Evolution – Things Have Changed

**1986**

**Government**



**Space  
Weather  
Products**



**Users**

*Commercial  
Academia  
Government*

*Models, Instruments, Space*



# Evolution (30 yrs)

**1986**

**Government**



**Space  
Weather  
Products**

*Models, Instruments, Space*



**Users**

*Commercial  
Academia  
Government*

**2016**

**Commercial**



**Academia**



**Government**



**Space  
Weather  
Products**

*Models, Instruments, Space*



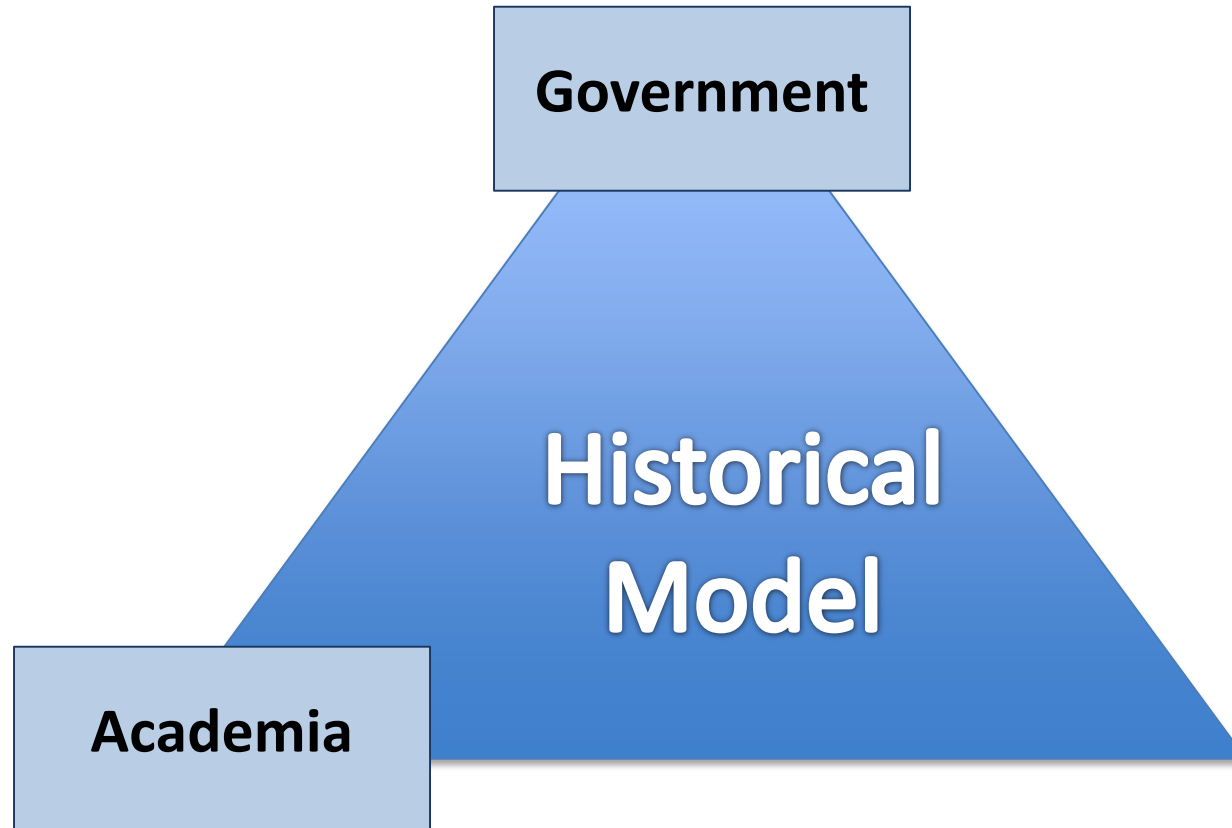
**Users**

*Commercial  
Academia  
Government  
International*

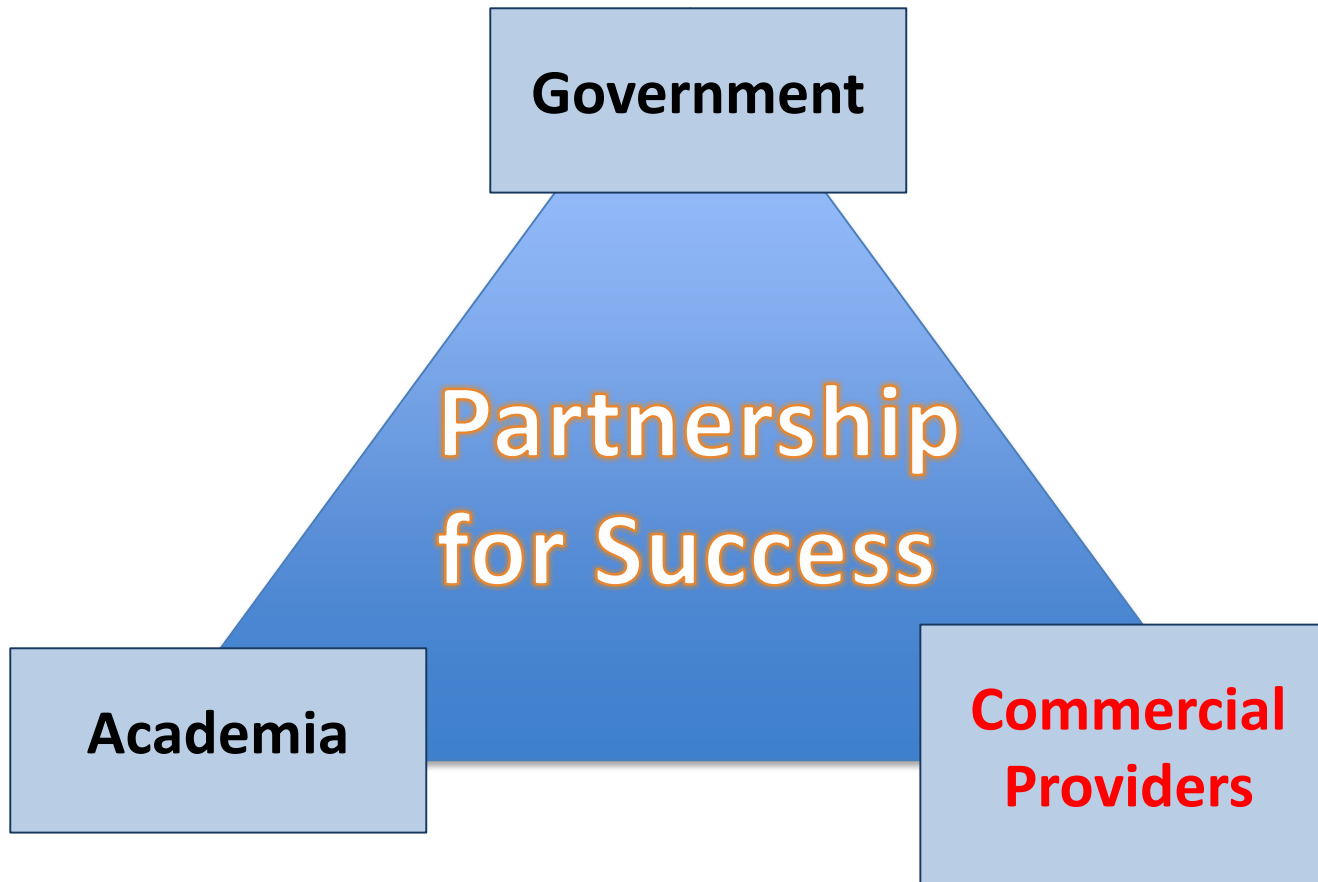


**\$ 1,000**

# Historical SpWx Enterprise



# Modern SpWx Enterprise





# **American Commercial Space Weather Association**

- **Founded in 2010**
- **19 commercial organizations**
  - ✓ **Represents interests of commercial SpWx providers**
  - ✓ **Represents commercial SpWx in nat'l & int'l arenas**
  - ✓ **Supports advisory services to government agencies**

## **ACSWA is helping to organize commercial SpWx**

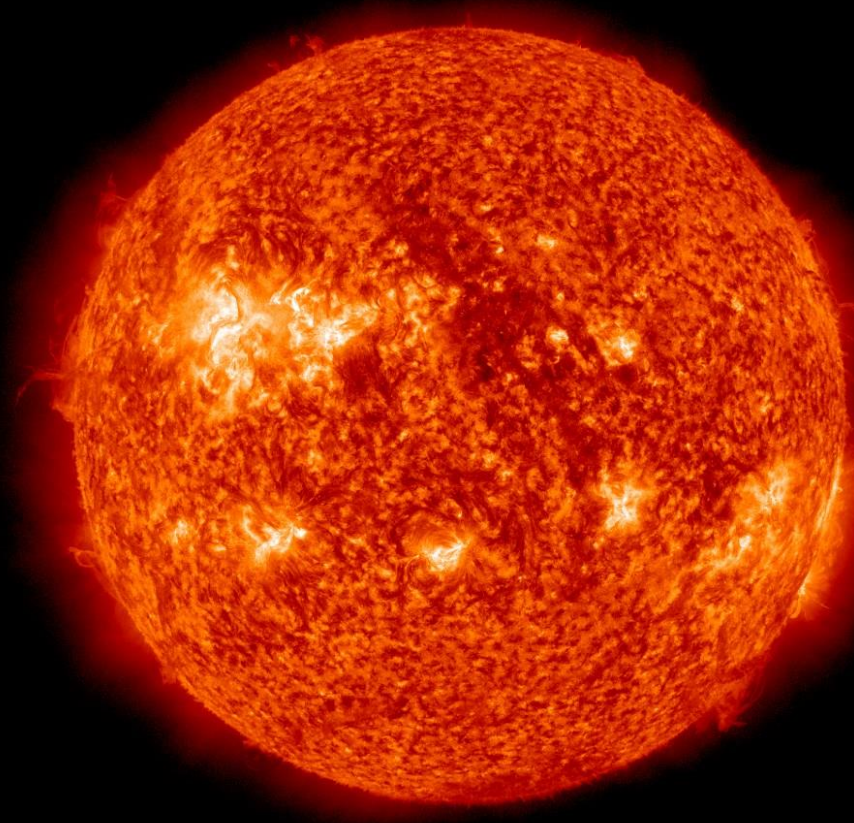
- ✓ **Providers of quality space weather data and services**
- ✓ **Developing operational space weather best-practices**

# **Examples of Commercial Capabilities**

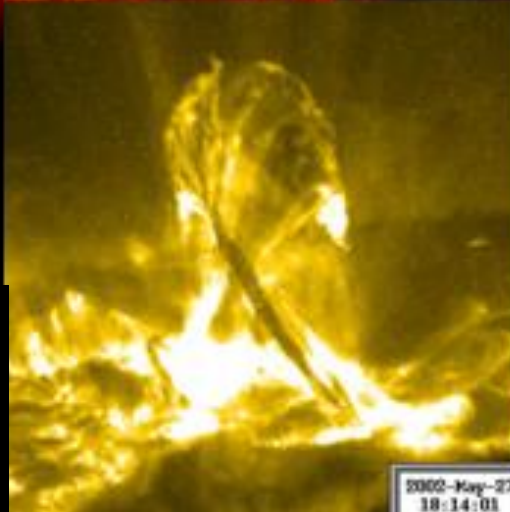




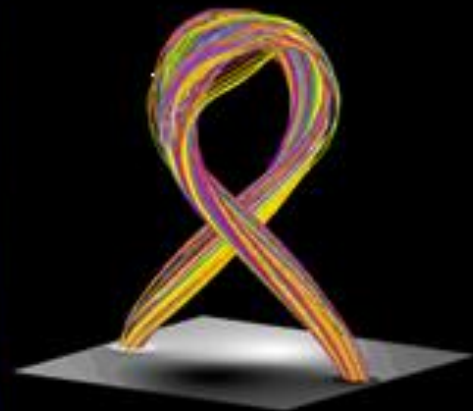
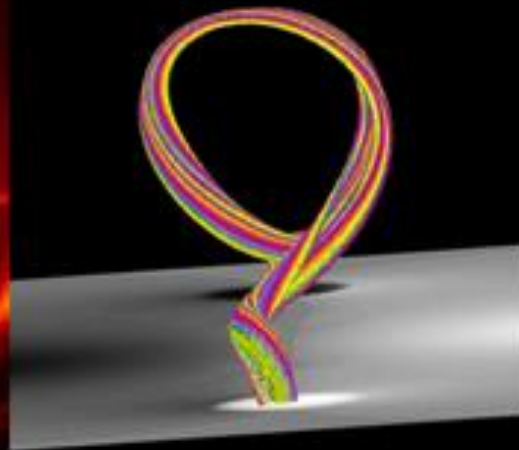
Predictive Science, Inc.



SDO/AIA 304 2012-06-04 11:15:45 UT



2002-May-27  
18:14:01



[www.predsci.com](http://www.predsci.com)



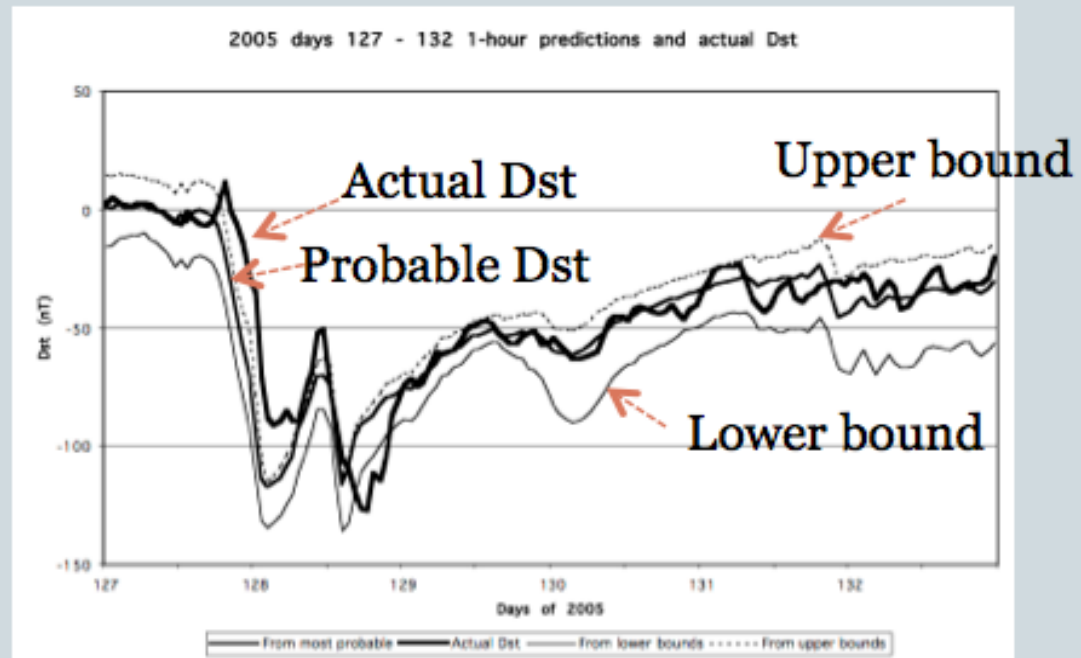


# *CARMEL RESEARCH CENTER (CRC)*

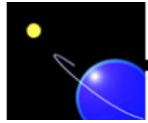
## CRC SPACE WEATHER FORECASTS



### ○ 1–5 hour forecast of Dst



Courtesy of Devrie Intriligator



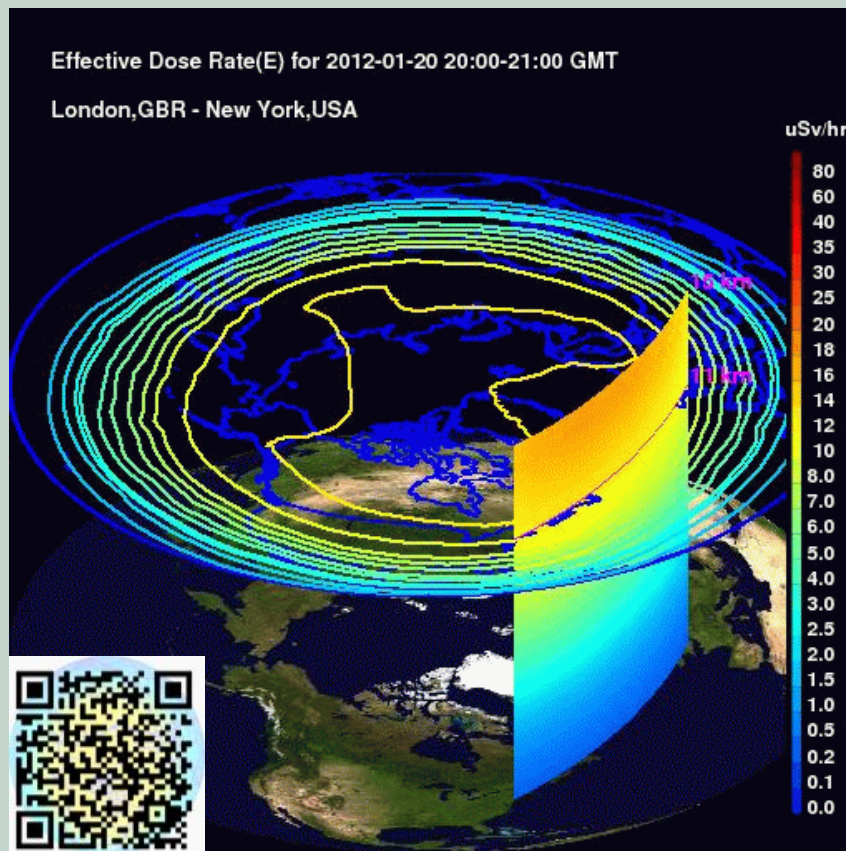
## SET's real-time aviation radiation monitoring system for business jets – ARMAS FM5

- **FM5 contains a micro dosimeter, data logger, GPS receiver, Iridium transceiver, battery, and Bluetooth in the size of a large smart phone**
- Measures ALL radiation in all altitude ranges with NASA technology
- **Reports personal dose exposure from anywhere in the world** providing REAL-TIME situational awareness onboard or on ground
- **Provides radiation region avoidance during events (like volcanic ash clouds)**
- FM5 is FAA compliant with its own power and no attachment to plane

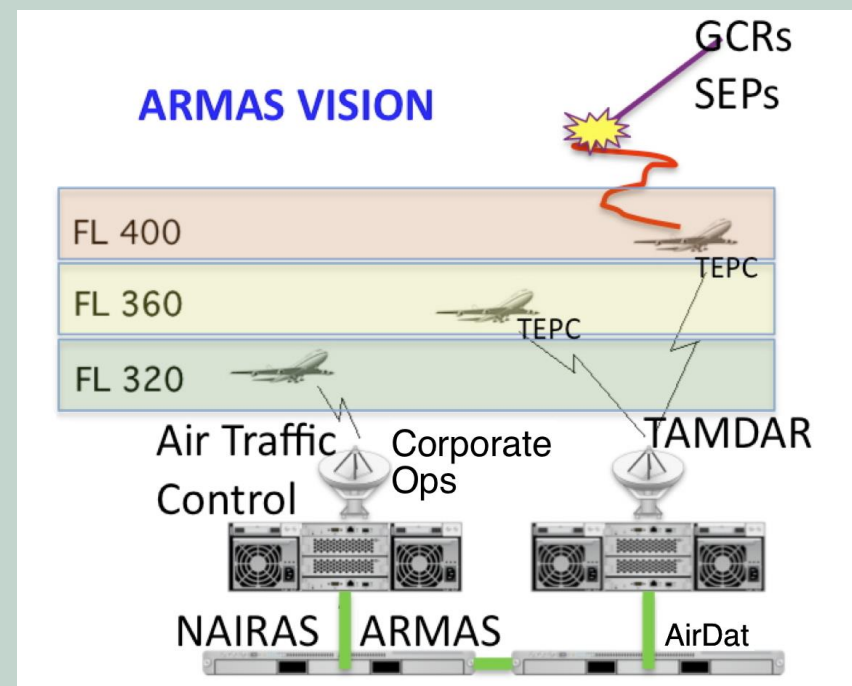


# Characterizing Radiation for Aviation Customers

## NAIRAS



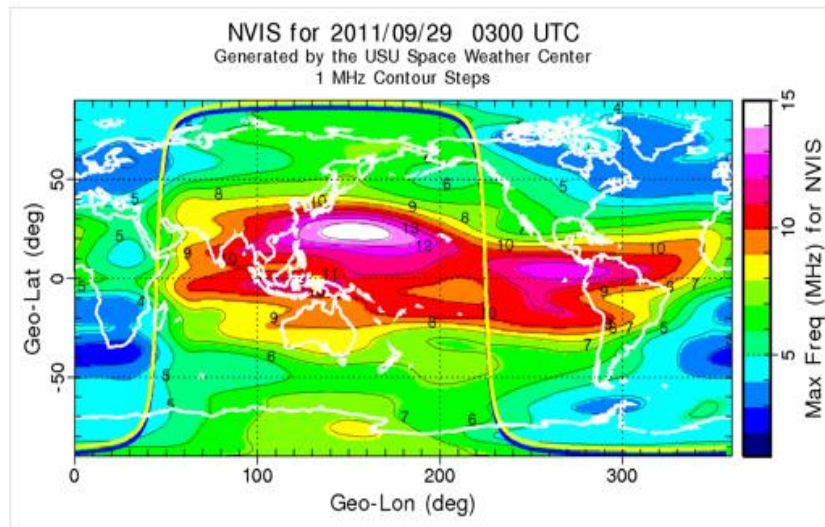
## ARMAS



Courtesy of Kent Tobiska



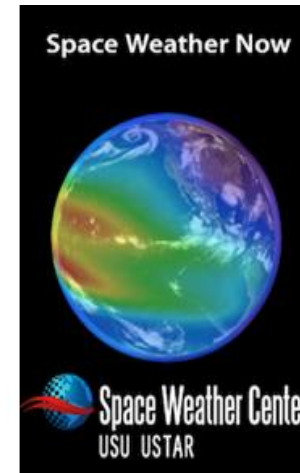
# Corporate and Hams HF propagation



At Q-Up Now we are dedicated to providing the best, most accurate real-time and forecast High Frequency (HF) radio frequencies for propagation.

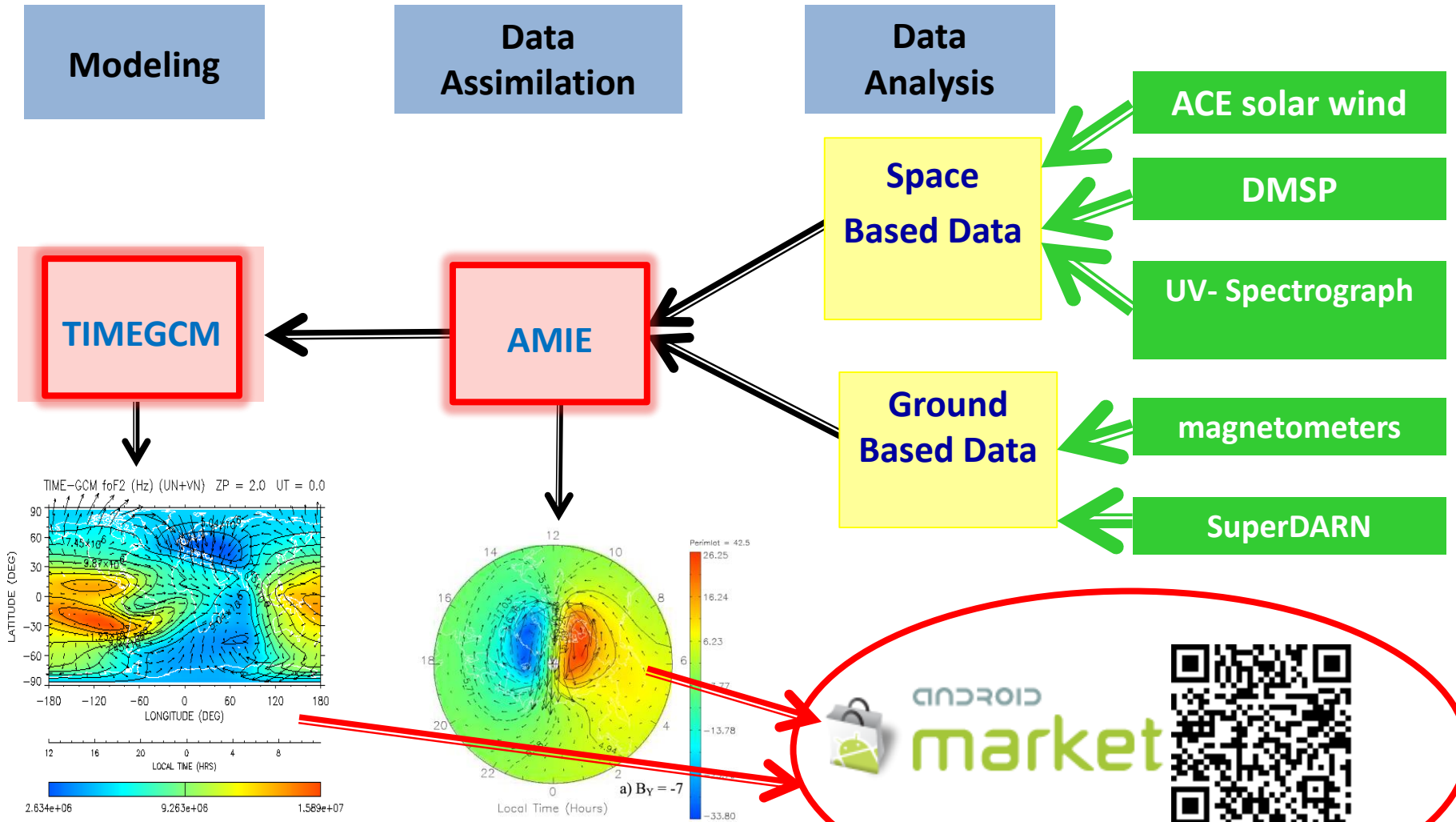
## What is Propagation?

Radio propagation is the transmission, including reflection, of a radio wave in a specific direction through a medium. Radio waves are a form of electromagnetic radiation (EM) and pass through free space, the ionosphere, air, and even solid materials. The reflections of the EM waves are affected by charged particles, such as electrons, in the ionosphere. As such, having a knowledge of how the ionosphere varies can help us understand how radio waves will propagate.



# Transition of AMIE & TIMEGCM Models

Assimilative Mapping of Ionospheric Electrodynamics  
Thermosphere-Ionosphere-Mesosphere-Electrodynamics-GCM



android  
**market**



[www.astraspaces.net](http://www.astraspaces.net)

# Real-time GPS Data Product

❖ Science

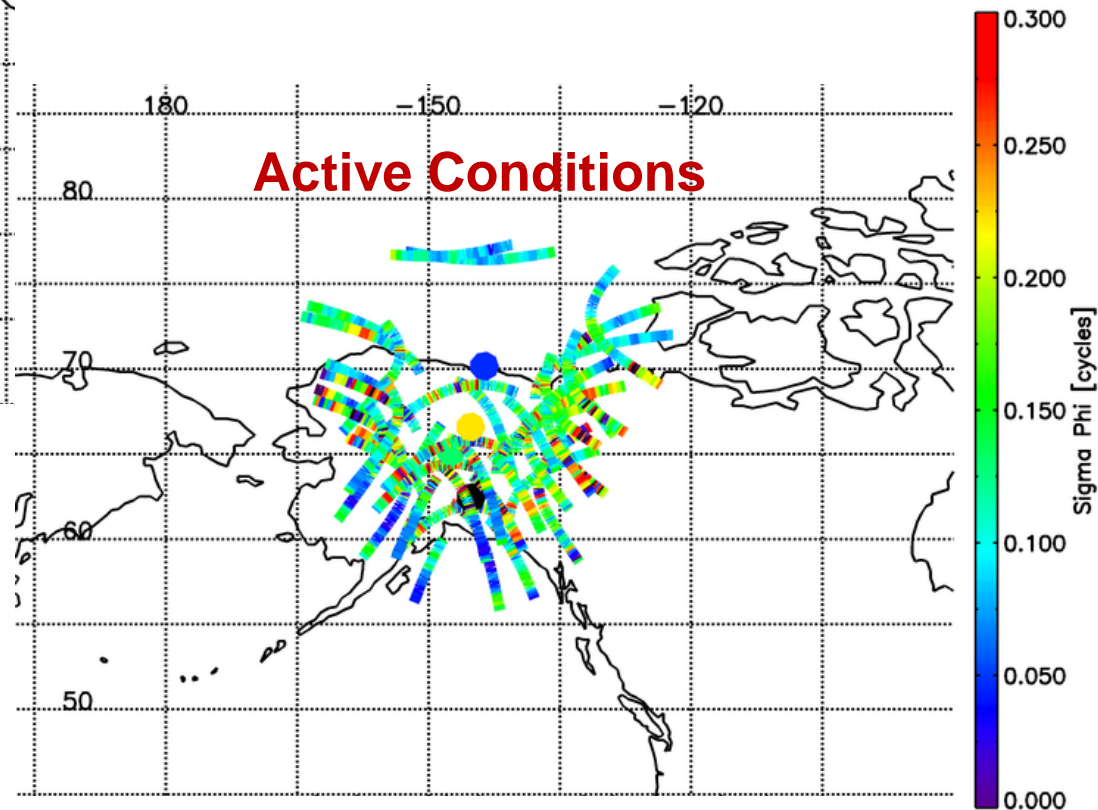
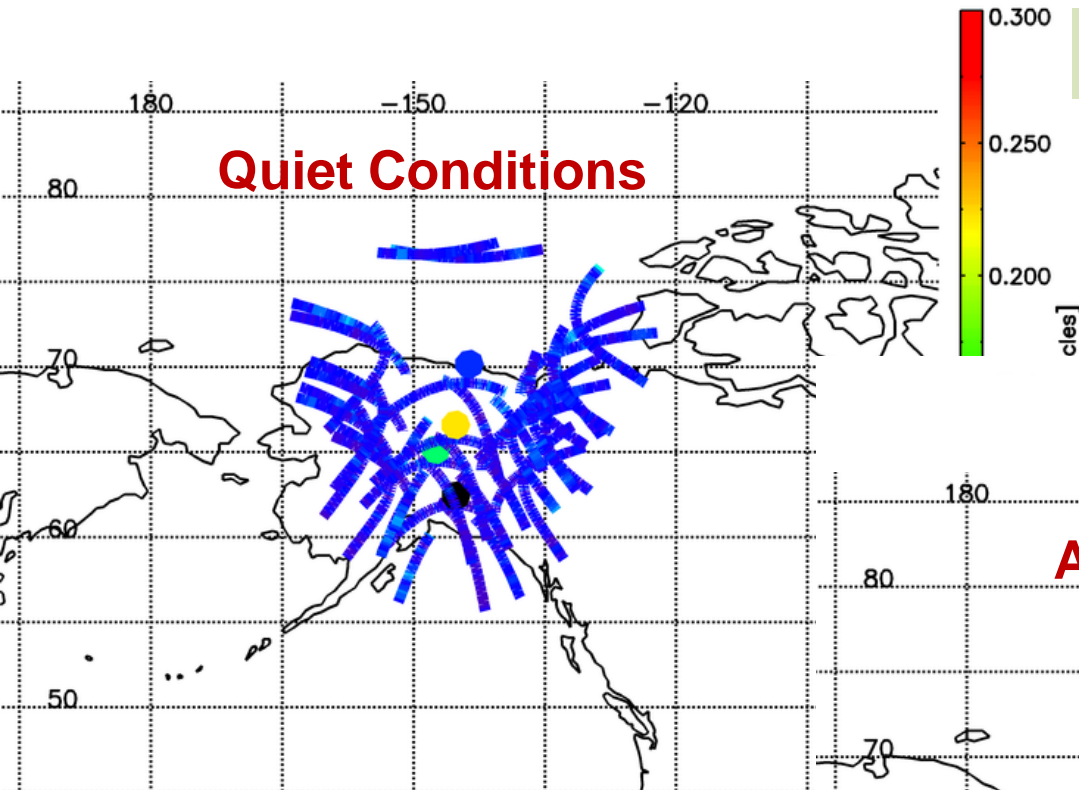
❖ Technology

❖ Applications

*Bringing It All Together*

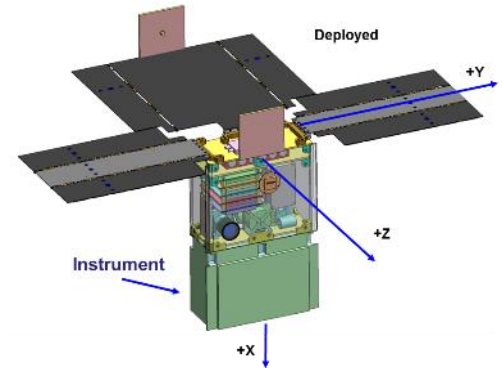
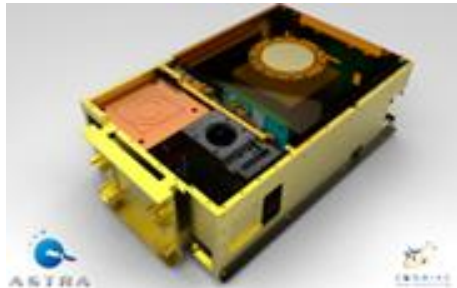
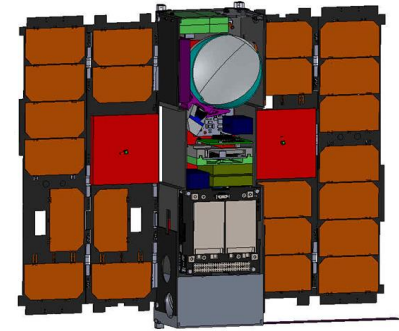
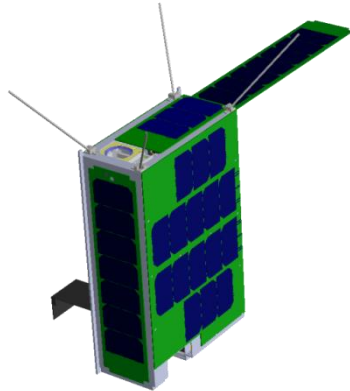
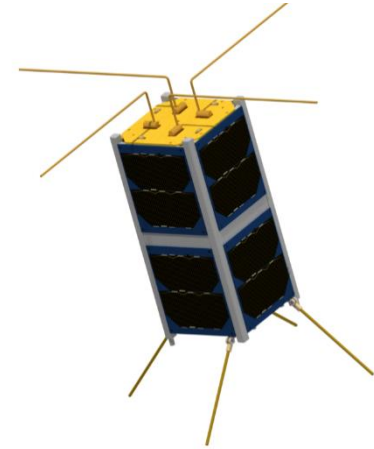
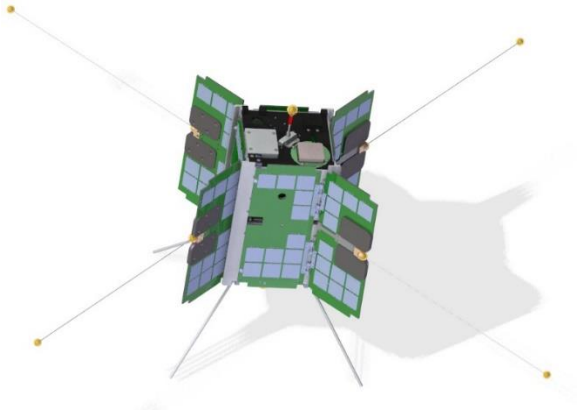


<http://cases.astraspace.net>



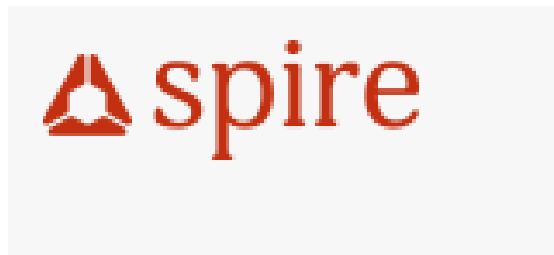


# Small Satellites and Cubesats





# Radio Occultation Constellations



# **How Can SWAP Utilize Commercial Sector Capabilities?**

## **NASA Technology Model**

**Program Manager reports to NASA Office of Chief Technologist  
(6 yr contract)**

**Assembled an Advisory committee including many industry people  
What can Commercial sector provide already?  
What technologies will be available soon from commercial sector?**

**What should NASA focus on, and what should they fund through SBIRs?**

## **Recommendation for SWARM/SWAP Tech Development**

**Establish a similar Advisory Committee for Space Weather Technologies  
Should include many commercial people  
Same questions....**

# **Funding Challenges**

**How can we fund commercial sector to take products from TRL3 to TRL9?**

- **BAA / RFP (Open or restricted access)**
- **SBIRs**
- **Seaport-E, etc (IDIQ Contracts)**
- **GSA (Pricing schedules)**

# Small Business Innovative Research

Government is encouraging small business to develop technology for operational capabilities

Phase-I Feasibility Study (TRL = 0 to 1)

Phase-II Proof of Concept, Prototype (TRL = 2 to 4/5)

**Valley of Death**

Phase-III Operational/Commercialization (TRL = 5 to 9)

Standard rule: Government has to compete everything (*takes time*)

SBIR rule: Government can sole-source to SBIR companies (*much quicker*)

Why?

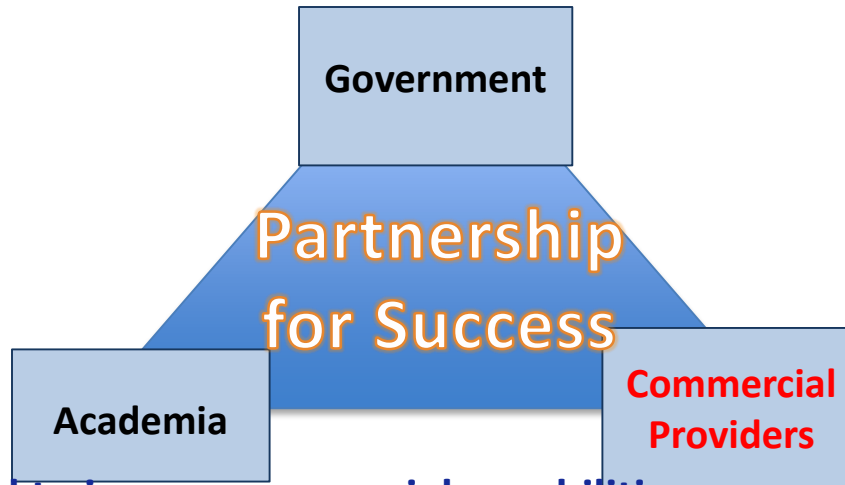
.... Government wants to see technology evolved to operational status

.... Return on Investment

# Conclusions



- Postulated a modern infrastructure for Space Weather Enterprise
- Differs from historical model



- Our nation can no longer afford to ignore commercial capabilities
- Commercial providers are among the best scientists in the field
- Skills and insights to share; sophisticated tools available ( > Govt and Academia)
- **Space Weather infrastructure should be modeled on the successful meteorological community: highly collaborative Govt-Academia-Commercial relationship**

**Ideas: 1) TRL level metric locates us in the R2O chain of action**  
**2) Technology Advisory Committee**  
**3) SBIR program is built around Research to Operations**

**Vision: Inclusive cooperation between Commercial Sector, Academia, and Agencies in the SpWx Enterprise**